

5.0 Data Retrieval

5.1 Overview

There are several issues associated with data retrieval (the process of extracting information from the EDR). The WG felt one of the main issues is that most OEMs have not offered tools to the public for retrieving EDR data. Recently, GM developed, through the Vetronix Corporation, a tool which would allow the public to download EDR data directly from many newer GM vehicles. Ford indicated to the WG that it did not have such a publicly available tool, but does have an engineering tool which they use to retrieve data from the airbag sensor. Ford envisions a common public tool for the future.

Today, hard wire connections are the most typical way to retrieve data from a vehicle. Wireless uplinks may be a common application for collecting EDR data in the near future. These systems may be stand-alone links or become part of an ACN system, which automatically relays the crash data stored in the EDR to a storage facility. SIS' MACBOX offers such a transmission and downloading procedure, where data are encrypted and transferred via a digital wireless network.

Aftermarket companies have included data retrieval as part of the overall design of their systems. Some systems are more complicated than others, but all have methodologies available to their customers to allow downloading data.

Truck EDR retrieval systems are being discussed by The Maintenance Council (TMC), part of the American Truck Associations (ATA). They have a recommended practice for interfacing the PCs with the vehicle's engine computer. Several truck engine manufacturers are currently offering various options of EDRs.

Downloading EDR data may require that the users be certified. The working group felt training would be beneficial, and noted that Vetronix Corp., was offering training for its CDR system. The WG also discussed fraud, but did not have any data to report that were related to this issue.

The WG discussed the benefits related to retrieval, the use of flight data recorders in the airline industry, and the need for SAE, or another professional organization, to assist the EDR industry in the area of data definitions and EDR standards.

5.2 Review of Issues Related to Data Retrieval

The working group developed a series of issues related to data retrieval. These included:

Issues Related to Data Retrieval	
Central data source must be robust	<ul style="list-style-type: none">• Submersion, fire, or other disruptive possibilities• Must survive the crash.
Power source	<ul style="list-style-type: none">• May not be any power in vehicle for retrieval• Crash damage may effect operation of computer data BUS
Wired EDRs vs. wireless EDR installations	
Reliability	
Size of the data collection equipment	
Information collected in various modules	

Protection of the data from fraud	
Access	<ul style="list-style-type: none"> ● Plug into a central BUS ● Connection to individual EDR (many of these are on the market and all have different interface technology. Also, crash damage may require connection directly to the individual EDR box)
Recording singular events vs. multiple events.	
Memory	<ul style="list-style-type: none"> ● Manufacturers record data for different lengths of time. ● Memory map could be standardized, additionally, other items could be standardized, including: what is recorded, format for recording, connector for retrieval, download tool for retrieval
Validity and accuracy of translation - WG felt that the technician downloading the data should always provide the "raw" data from the download, for example "hex dump."	
Standardization of interface protocol.	
Interpretation of data collected related to damage of vehicle.	

5.3 Vetronix Data Retrieval System

In March of 2000, Vetronix Corporation began selling its Crash Data Retrieval (CDR) system. The CDR system (See Figure 16) is the first and only tool available to the public that allows users to download data from the event data recorders installed on passenger and light-duty vehicles.

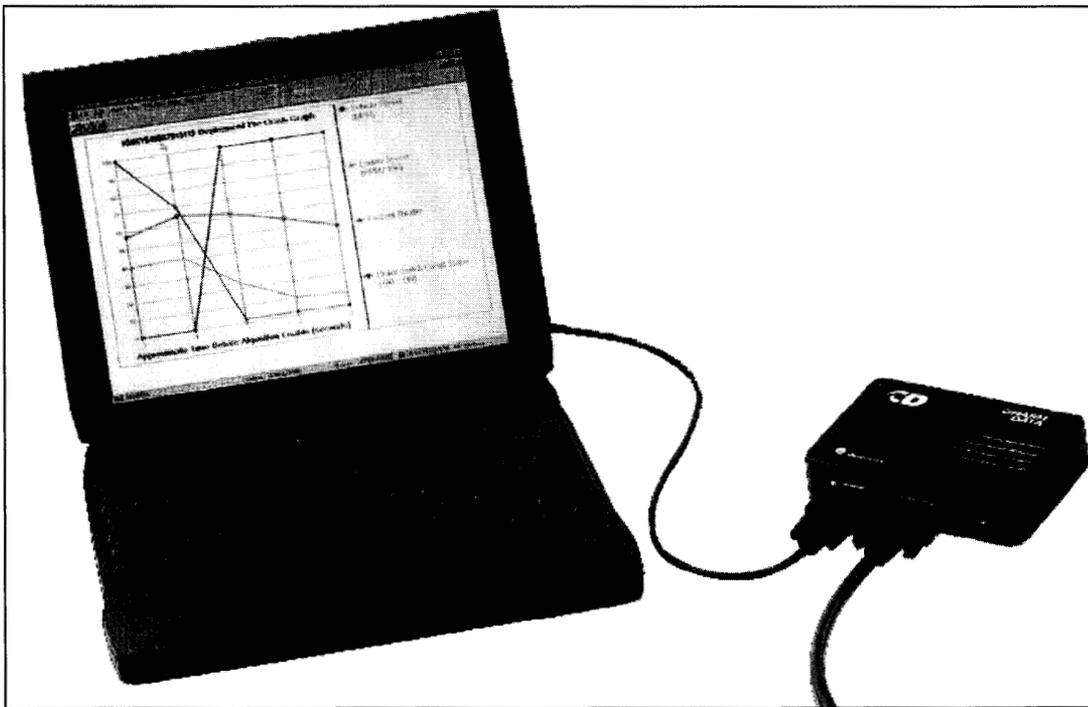


Figure 16. Vetronix EDR Data Retrieval System.

Currently, Vetronix has agreements with GM and Ford to write software that allows users to download hexadecimal data from their EDRs. The Windows® based CDR software then converts this data into easy-to-read graphs and tables.

Vetronix has designed its hardware in anticipation that other vehicle manufacturers will come on board. To support a new vehicle manufacturer, only a software and cable update is necessary.

The CDR system allows users to connect directly to the vehicle's diagnostic link connector (DLC), typically located below the steering wheel, or directly to the EDR in cases where the vehicle's electrical system has been damaged during a crash.

The CDR system is currently used by over thirty different law enforcement agencies (in the U.S. and Canada), NHTSA, GM, Ford, IIHS, insurance companies, and private crash reconstructionists.

Beginning in fall 2001, federal grant money is available through NHTSA for law enforcement agencies to purchase the Vetronix CDR system. For more information, the appropriate regional NHTSA office (www.nhtsa.dot.gov) should be contacted.

The CDR system costs \$2,495. For further information regarding this tool, contact:

Vetronix Corporation
2030 Alameda Padre Serra; Santa Barbara, CA 93103
(800) 321-4889; (805) 966-2000; (805) 965-3497 Fax
www.vetronix.com

5.4 Other Data Retrieval Tools

Aftermarket manufacturers of EDR technology include retrieval methodology as part of their product. Typically, the retrieval system is included as part of the system, or the output is in an industry accepted standard, such as standard formatted video output. The following presents some examples of these aftermarket strategies for data retrieval:

SIS: With the SIS MACBOX, encrypted crash data are transmitted over a digital wireless network, then decoded and downloaded to a secure data storage facility. Manual downloading directly from the vehicle, by appropriate entities with authority to view the data, could also be done if a transmission failure occurs.

DriveCam: The video, sound, and G-forces relating to the crash are played on a standard television or camcorder and can be recorded on videotape or a computer hard drive. Pressing the play, rewind, or forward buttons on DriveCam operates it like a VCR. An on screen display shows in real time the G-Force measurements experienced with audio and video in real time.

IWI: The data are stored in the Witness and can be accessed immediately for verification at the scene of an collision with a laptop computer, using IWI interface products. Upon extraction of the recorded data, the information is downloaded to IWI via the Internet. Once IWI's website is accessed, a full report can be immediately printed outlining the crash severity and injury potential details.

5.5 Data Retrieval at NHTSA

NHTSA began collecting crash data from EDRs in the mid 1990s. The early efforts involved cooperation between the NHTSA and the automobile manufacturers. Data was typically collected by NHTSA's Special Crash Investigation (SCI) program to support crash investigation activities. Two methods were employed -- the boxes were removed by the agency and sent to the manufacturer for downloading or the manufacturer sent a representative to the crashed vehicle to directly read the data. The process still continues today for some manufacturers.

During the late 1990s General Motors licensed to Vetronix the right to manufacture and sell EDR download tools which could interface with GM motor vehicles. In 2000, NHTSA equipped the crash investigation teams with these tools: including the SCI teams, the Crash Injury Research and Engineering Network (CIREN) crash investigation teams, and the NASS Crashworthiness Data System crash investigation teams. The teams were trained on proper use of these tools, and have begun collection of EDR data on a routine basis. To date, the NHTSA crash investigation teams have investigated nearly 100 crashes where an EDR was read.

6.0 Data Collection and Storage

6.1 Overview

Data collection and storage is the least developed area related to EDRs. Most organizations have developed collection and storage systems/databases to suit the need for their own programs. Until recently, there was no national effort to collect and store EDR crash data. About a year ago, NHTSA modified its national data bases, SCI, CIREN, and NASS-CDS, so they could capture EDR data retrieved in a crash investigation.

The working group also discussed evidence and traceability issues related to collection and storage. Manufacturers stated that they needed to know where the data originates.

The group considered how different users affect collection and storage. That is, federal collection would make the data public (with in the constraints of the current privacy laws) while insurance companies may want to keep data they collect private.

6.2 Data Collection and Storage Activities

Several aftermarket and OEM companies have been collecting EDR data. Aftermarket companies tend to collect data for their clients, while OEM companies collect EDR data for internal engineering analyses required to improve occupant safety. NHTSA, FHWA, FMCSA, and some states collect data for use in setting public policy, regulating commercial vehicle operations, and also makes the data public through its public sharing process.

Some aftermarket companies are providing collection and storage as part of the service for their clients. IWI collects and stores data from many customers into a common data base.

7.0 Permanent Record

7.1 Overview

Currently, there are many companies storing data for their corporate purposes, but typically these data are confidential and cannot be accessed by the public. NHTSA recently starting using its NASS-CDS, SCI, and CIREN databases as the first publicly accessible permanent records where EDR data are stored. Because of the time lag to get cases in the NHTSA databases, they're only a few cases public, but more will become public in the near future.

Since the use of EDR data is still in its early stages of development, it will be some time before large databases populated with EDR data exist. Generally, the database needs to have a function beyond that of storing EDR data, hence, the early EDR databases will be added onto other currently-existing databases, such as NASS-CDS. Specialty databases, created for the sole collection of EDR data will gain popularity as EDR data collection become more automated.

The working group believes there is a need for a central repository for EDR data. The Federal role is limited, since NHTSA only collects data on crashes related to its internal crash data collection programs. Additional efforts will be required to explore the possibility of a National EDR database.

7.2 Examples of EDR Data

NHTSA: As discussed above, NHTSA collects crash data in three major vehicle crash programs: **NASS-CDS** – a national statistically sampled data base, currently collecting data on about 4,000 crashes each year at 24 locations around the U.S.; **CIREN** – a system of crash investigations conducted at hospitals, collecting about 400 cases per year; and **SCI** – a collection of targeted crash investigations looking at emerging safety issues. While a few SCI cases had been collected in previous years, it was not until 2000 that these groups started collecting and entering EDR data into their associated databases. Each database has been modified to contain a field which indicates if the case has an associated EDR file. This data element is part of the searchable electronic file associated with the database. Since the data collected by various EDR manufacturers is not uniform, NHTSA has chosen not to attempt to store the output in the electronic file. Rather, NHTSA has implemented a policy which enters a electronic image of the EDR output into the file. This allows the researcher to review the various data elements (for example: DV for GM vehicles vs. acceleration profiles for Ford vehicles).

SIS: SIS, the developers of the MACBOX, in a strategic partnership with Insurance Services Office, Inc., have created a separate entity, Global Safety Data Corporation, for the sole and exclusive purpose of providing a secure, private data vault to store and manage all the EDR data. This data vault will include the necessary privacy filters and security firewalls required to ensure that only authorized users have access to the crash data.

IWI: IWI maintains a database (Accident Severity and Injury Potential {ASIP}) which tracks EDR data from the crashes recorded by their EDR systems installed in vehicles in various parts of the country. The information is correlated with the injury claims, medical treatment, recovery time, pre-existing conditions, and other qualifiers (age, sex, occupation, hobbies, income, prior claims, etc.), creating a database capable of “objectively” predicting the probability of injury based on the forces involved in the collision. The database, based on real world data, will be used by claims adjusters, risk managers, and worker’s compensation analysts to accurately and fairly assess the subjective injuries that result from a given crash. The ASIP will also correlate crash force with injury potential.

DriveCam: DriveCam is currently developing a program that will be able to read EDR information from the several EDR software programs already in use and put them into a common readable format. This will greatly simplify databasing of crashes with a standard file format that will allow researchers around the world to download crash files over the Internet and view them with a one familiar program. This software program is called Hindsight 20/20.

States: States may have a role in developing permanent databases for EDR data. State agencies, such as police and crash investigators, will soon begin to use EDR data as part of their crash investigation process. As they do, these data could become available at the state level for storage. These data could be transferred to the federal government along with other state data currently shared between the states and NHTSA, hence becoming part of the NHTSA permanent record associated with the Fatality Analysis Reporting System (FARS) and electronic state data files. Currently state data are reported using electronic formats, so the EDR data would need to be converted from the paper output, currently generated, to an electronic format compatible with the state files.

8.0 Privacy and Legal Issues

8.1 Overview

The issues of ownership of information collected by an EDR and the effect on the privacy rights of individuals involved in the recorded events will need to be further explored with the development of the technology. The following discussions may have application to many types of transportation recordings, but the focus of this working group was the privacy and legal issues associated with recording data for a very short time period (for example, less than a minute during a crash), and with the capture of the data on the vehicle, not automatic transmission of the data to a PSAP or other service provider. Since these topics cannot always be disconnected, some overlaps in the discussions occur.

The fundamental issue is the need for information collected from an EDR to increase safety yet protects the privacy of individuals affected by the information collected from an EDR.

In April 2000, the NTSB sponsored an international symposium regarding legal and privacy issues related to transportation recorders. While considering mostly aviation, pipeline, sea, rail, and commercial highway vehicles with very little emphasis on noncommercial highway vehicles (such as automobiles), “Transportation Safety and the Law,” offered expert opinions from leaders in the area of recorders. With a theme of improving transportation safety and the use of available information in the 21st Century, the symposium addressed such items as: 1) How can the generation of data and information enhance transportation safety? 2) What are the implications of government investigations and private litigation for information development? 3) What is the proper governmental approach to encourage the availability of data for legitimate uses? The proceedings from the symposium can be viewed in their entirety at: http://www.nts.gov/events/2000/symp_legal/default.htm

8.2 Federal Law

8.2.1 Privacy Act

The Privacy Act of 1974, 5 U.S.C. §552a (the Act) provides that no federal agency shall disclose any of its records which are contained in a system of records by any means of communication to any person, or to another agency, except pursuant to a written request by, or with the prior written consent of, the individual to whom the record pertains, unless disclosure of the record would be pursuant to one of the exceptions outlined in section (b) of the Act.

The purpose of the Act is to balance the government’s need to maintain information about individuals with the right of individuals to be protected against unwarranted invasions of their privacy stemming from federal agencies’ collection, maintenance, use, and disclosure of personal information about them. The Act focuses on four basic policy objectives:

- To restrict disclosure of personally identifiable records maintained by agencies.
- To grant individuals increased rights of access to agency records maintained on themselves.
- To grant individuals the right to seek amendment of agency records maintained on themselves upon a showing that the records are not accurate, relevant, timely or complete.
- To establish a code of “fair information practices” which requires agencies to comply with statutory norms for collection, maintenance, and dissemination of records.

8.2.2 Other Statutory Authority for NHTSA Data Collection

NHTSA is authorized by Congress (15 U.S.C. §1395, 1401 and 23 U.S.C. §403) to collect statistical data on motor vehicle traffic crashes to aid in the development, implementation and

evaluation of motor vehicle and highway safety countermeasures. This also prohibits the disclosure of personal information that the agency would receive as a result of crash investigations.

Exemption 6 of the Freedom of Information Act, 5 U.S.C. §552(b)(6) prohibits disclosure of personal information received by the agency that, if disclosed, would constitute a clearly unwarranted invasion of personal privacy.

8.2.3 Federal Court Decisions

Since the EDR technology is in the developmental stages, there is no case law available in this area of law. The most recent case that relates to EDR technology involves the Diagnostic and Energy Reserve Module (DERM), which was described by an engineer with General Motors as “like an airplane ‘black box.’” In this case, the Plaintiff sued General Motors alleging that the airbag deployed after rather than during a low-speed collision, resulting in injury to plaintiff. Although this case was decided on procedural grounds, the engineer for General Motors submitted an affidavit stating that he had downloaded data from the DERM and concluded that the DERM data from the vehicle suggests that the supplemental restraint system functioned as designed by deploying during the plaintiff’s crash. See, Harris v. General Motors Corporation, 201 F.3d 800, 804 (6th Cir. 2000).

There are other cases that mention “black boxes,” but these cases describe the role of the “black box” as evidence in the case. See, In re Korean Airlines Disaster of September 1, 1983, 156 F.R.D. 18 (D.C. Cir. 1994)(where the release and analysis of the flight data recorder were evaluated and determined to be newly discovered evidence); Sundstrom v. McDonnell Douglas Corp., 816 F.Supp. 587 (N.D. Cal. 1993)(wrongful death suit where the seat data recorder in USAF planes was alleged to be a defective design, manufacture and assembly); In re Air Crash Disaster at Sioux City, Iowa, on July 19, 1999, 131 F.R.D. 127 (N.D. Ill. 1990)(the court held a flight simulator was not needed where sufficient evidence was available using the flight data recorder and the cockpit voice recorder).

8.3 Who Owns the Data

This section presents the views of several of the WG participants.

8.3.1 Position of the National Highway Traffic Safety Administration

It is NHTSA’s position that the owner of the subject vehicle owns the data from the EDR. In order to gain access to the data NHTSA must obtain a release for the data from the owner of the vehicle. In crash investigations conducted by NHTSA, the agency assures the owner that all of NHTSA’s personal identifiable information will be held confidential pursuant to the Privacy Act (5 U.S.C. § 552a) and other statutory authorities which limit disclosure of personal information. Any information derived from the crash investigation, including an EDR, that would lead to personal identifiable information may not be disclosed pursuant to the Privacy Act.

8.3.2 Position of the Federal Highway Administration

According to the Federal Highway Administration’s Office of Chief Counsel, vehicles are sold to consumers without any vestigial interests retained by the manufacturers. If the EDR is treated in this way, however, the vehicle owner would presumably own the data as well. This would hamper the ability of public authorities to access the data by requiring permission from the owner. In addition to the obvious practical difficulties of obtaining permission at the crash scene, the owner would also presumably retain the ability to withhold the data if he felt this would serve his self interest.

A further level of complexity occurs when a supplier, rather than the motor vehicle manufacturer, retains ownership of the data. In Europe, for example, the suppliers essentially control access to the data by utilizing proprietary protocols that prevent anyone else from accessing the data, though they do report the results of the data extraction.

The problems related to ownership might be resolved by some sort of retention of ownership by manufacturer, by a contractual retention of rights to access the data (perhaps similar to an easement in real property), by a provision in state motor vehicle licensing laws, or by some other federal regulation that permits public authorities to access the data regardless of ownership.

8.3.3 Position of Insurance Companies

Many insurance companies have not explored the legal obligation concerning the EDR. For example, one insurance company advised NHTSA it has looked into the technology, but has not looked into any ownership issues. Another insurance company advised that it has not explored the issue of ownership extensively, but concluded summarily that if the insurance company gains ownership of the vehicle, it then owns the EDR data.

The complications develop when ownership of the vehicle does not get transferred to the insurance company. The insurance industry believes an argument can be made that the existing standard policy language may allow the insurance company access to data from the EDR. For example, the standard Insurance Services Office, Inc. formatted Personal Auto Insurance Policy Agreement states that the owner “authorize[s] us to obtain . . . other pertinent records.” The phrase “other pertinent records” may include the data from the EDR.

8.3.4 Position of Volkswagen

Federal and in many instances state law, with certain exceptions, prohibit the disclosure of any document to any person or another agency except with the written consent of the person to whom the record pertains. The purposes of these statutes are to protect the individual against infringing upon his or her rights to privacy as agencies embark upon data collections for multiple purposes. Certain private businesses are similarly regulated by federal and/or state law, i.e., the credit reporting industry.

The extent to which a vehicle owner has a right to privacy regarding EDR data depends in Volkswagen’s view on whether or not the data identifies the individual person or event, or whether or not the individual person is deemed to have given his or her consent to the use of the data in the manner proposed.

It is Volkswagen’s position that irrespective of how any particular data relating to the crash is proposed to be used, if it permits identification of the individual person tied to the accident, that person should be advised of its proposed collection and use regardless of whether or not the law requires it.

8.3.5 Position of General Motors

The risk of private citizens reacting negatively to the “monitoring” function of the EDR can be diffused through honest and open communications to customers through owners’ manuals by telling them such information is recorded. The acceptance of recording this data is more likely if the “monitored” data is used to improve the product or improving the general cause of public safety.

8.3.6 Position of Safety Intelligence Systems, Corp, Lindenhurst, New York

Vehicular EDRs must be developed to improve transportation safety by utilizing all 21st century information technology available. The goal is to improve highway safety while protecting the privacy of the individuals affected by the information collected. Crash data assembly has the potential for great public safety benefit but the data must be separated from personal identifiers.

Administrative structures presently exist to collect aggregate crash data without personal information being revealed. Examples include government agencies (highway safety research), auto manufacturers (improving design and safety) and insurance companies (maintaining underwriting records). In some research studies utilizing EDRs in vehicles, the confidentiality of the owners and operators is protected by having numbers assigned to the individual test vehicles rather than the owners' name. Accordingly, the cumulative data assembled can be studied without identifying the names of the owners and operators involved.

With regard to EDR data, there must be a secure and private data vault to store and manage all aggregate vehicular crash data. This data vault must include the necessary privacy filters and security firewalls required to ensure that only authorized users have access to the crash data. This data vault would complement the current data gathering and analysis activities of existing federal and private databases. The cumulative data stored in the security vault could then be made available to the public, government agencies, auto manufacturers, insurance companies, and other authorized entities as needed.

8.3.7 Position of Susan Walker, Esq., Kanouse & Walker, Florida

A possible legal model for the legal implementation of EDR technology would retain all rights with the owner of the motor vehicle. The decisions as to whether to install aftermarket EDR technology and use the data would be vested with the owner of the vehicle.

She envisions the data would be collected in hardware located in the motor vehicle and then be wirelessly transmitted in an encrypted and encoded format to a central data repository. The transmission of the data would occur on a regular basis and contemporaneously with an event. No data would remain in the vehicle after an event. The central repository would be an independent agency which has yet been determined.

The data generated would be identified by the VIN, which is given to all vehicles. The personal identity of the owner would remain confidential, unless permission was given by the owner of the information to use such data.

The central repository would be free to use the cumulative form of any data, which could be available to the public, car manufacturers, insurance companies and others. The personal information would be treated as "privileged" information, a concept similar to the patient/doctor privilege. The privilege may be "waived" by its owner, and when the privilege is waived the information may be released.

In civil court proceedings (which include individuals seeking monetary damages), the privilege could be absolute or qualified. In criminal court proceedings, (which involves the state seeking criminal sanctions against an individual), the data would be protected and the individual would be afforded the constitutional protections of the Fifth Amendment right against self-incrimination, so too, the Fourth Amendment rights of the individual against unreasonable search and seizure would be afforded as to the collection of data.

The delicate balance between the need to save lives by obtaining and prudently using critical data and the need to respect the expectations of privacy, constitutional safeguards, and due process, must be preserved. The model envisions that personal choices be preserved for the owner of the vehicle.

8.3.8 Position of Thomas Michael Kowalick, Click, Inc, North Carolina

Mr. Kowalick advised that all data collected and stored should make use of data security technology and audit procedures appropriate to the sensitivity of the information. EDR technology data storage should include protocols that call for the purging of individual identifier information respectful of the individual's interest in privacy. Information collected should be relevant to the purpose and a mission statement associated with the EDR disclosure statement.

Privacy is an important issue regarding the success or failure of implementing the EDR. Individual motorists and occupants have an explicit right to privacy. Although this right to privacy is not explicitly granted in the Constitution, it has been recognized that individual privacy is a basic prerequisite for the functioning of a democratic society. Indeed an individual's sense of freedom and identity depends a great deal on governmental respect for privacy. Therefore all efforts associated with introducing future EDR technologies must recognize and respect the individual's interests in privacy and information use. Thus, it is imperative to respect the individual's expectation of privacy and the opportunity to express choice. This requires disclosure and the opportunity for individuals to express choice, especially in regards to aftermarket products.

Disclosure must be constant and consistent. Any data collected via EDR technologies should comply with state and federal laws governing privacy and information use. All data collected and stored should make use of data security technology and audit procedures appropriate to the sensitivity of the information. EDR technology data storage should include protocols that call for the purging of individual identifier information respectful of the individual's interest in privacy.

9.0 Customers and Uses of EDR Data

9.1 Overview

Based on the data collected by the WG, the customers appear in two major categories: Non-Real time and Real time. Non-real time users comprise all the current users of EDR data. Non-Real time users typically included government, police, researchers, insurance companies, and other crash reconstruction experts. These customers normally begin their work after the crash EMS and crash cleanup personnel have completed their work, and the collection of the data is not time-critical, that is, they can wait for a few hours, to days or months to collect the data, as long as the data is preserved in the EDR memory. Real time customers of crash data tend to be those which could use the data at the crash scene to improve injury and death outcomes. This use is the most time-sensitive and could be read by the EMS personnel at the crash site or augmented with an ACN system to transmit the data. The WG did not find any current examples of real-time EDR data users.

The WG developed an overview of all the customers for EDR data, of which most fell into the Non-real time user category. Customers were divided into 5 major categories:

R&D (including: OEM, Governments, Academics)

Incident Management (including: Law Enforcement, Medical, Insurance Companies, On-scene crash investigators)

Fault Assignment (including: Authorities {police, court}, OEM & Government, Insurance Companies through claims, Negotiated settlements, Courts, Juries, Judges)

Driver (including: Personal Data, Vehicle Performance)

Owner (including: Fleet, Personal, Self-Insured)

The following presents the customer overview, along with some observations:

Manufacturers	Vehicle manufacturers indicated they were typically installing EDRs to collect data to improve the design of motor vehicles and diagnose vehicle systems.
Government	The government users fell into several levels of government -- the federal level, state level, and other local users. The WG observed that the federal role included uses of EDR data to carry out its mission: to save lives, reduce injuries, and property loss. This could include collecting data to assist in a better safety management system for the highway and traffic systems. The federal government could also utilize these data to assess safety problems and solutions for issuing new and revised vehicle safety performance standards. At the state level, crash data could be used to assist states in managing road systems and designing better roadside safety hardware, such as guardrails and crash cushions. These groups are very interested in collecting crash location information that would vastly improve their ability to improve roadside safety. At the local level, EDR data could be used to assist medical EMS control, especially if EDR data could be automatically dispatched from the crashed vehicle to the PSAP center as well as other affected parties. EDR data would help the local authorities assign the "right" response teams early in the event. The WG felt it was the governments' role to lay a foundation to cooperatively use these data.
Law Enforcement	These users would benefit greatly from obtaining quick and impartial information regarding the crash. They are often charged with determining the facts associated with a crash, and these data would give them

	additional tools to validate field collision data, determine crash causation, and fraud.
Insurance Companies	Insurance companies often analyze a collision claim for validity prior to paying the claim. EDR data will allow these customers of EDR data to obtain more accurate data related to the crash.
Plaintiffs, Defense Attorneys, Judges, Juries, Courts, and Prosecutors	This group of users often obtain costly experts in the field of crash reconstruction to assist them in proving their position. The use of EDR data will put more “science” on the table during these actions and could lead to shorter actions or no action altogether. Juries would get objective information, too. Courts could require vehicles be equipped with recording devices.
Human Factors Research	Human factor researchers are continuously looking for more data to understand the human’s involvement associated with crash causation. Pre-crash EDR data could be used by these researchers to understand driver performance and conduct further analysis of this complicated issue in an in situ environment.
State Insurance Commissioners	Insurance officials could use EDR data to support decisions regarding insurance rates, such as, approving discounts for owners who pre-agree to release EDR data should a crash occur.
Parent Groups	These customers, such as MADD and other parent groups, could use EDR data to support trends in crashes.
Fleets & Drivers	These devices could be used by drivers/fleet owners in many ways, including: improving driver safety, educating drivers about technology on vehicles, auto-downloading data for driver use, providing information vehicle safety characteristics (data element related), and providing information regarding the general performance of vehicle. Another primary use of EDR data by the driver/owner could be the use of the data to demonstrate their proper vehicle operation during a collision.
Medical Injury Guideline Data Usage	Hospital officials, EMS providers, and other EMS decision makers could use EDR data to improve field triage decisions. These data could be used to trigger a series of events which would ensure that the “right” help got to the crash and ER staff to look for non-visible injuries. While more related to ACN, these new methodologies could save lives.
Vehicle Owner	The vehicle owner could review EDR data to determine if the vehicle had been in a previous crash. These data would indicate the severity of the crash, which may relate to the level of repairs the vehicle had undergone during its life.
Transportation Researchers & Academics	Transportation researchers could use EDR data to conduct research related to vehicles, highway, medical treatments, etc.

9.2 Potential Uses of EDRs

There were many discussions related to using EDR data. They are generally summarized in the table above, but some more specific ideas were presented to the WG, and are detailed as follows:

DriveCam: During the process of developing their EDR technology, the DriveCam staff developed a list of “current problems” faced by drivers, and a set of solutions which an EDR could offer. While these were developed directly for the DriveCam EDR technology which included video capturing, they are applicable to EDR application in general and are included as part of the EDR WG report.

Current Problems	EDR Solutions
Reliable, valid collaboration of eyewitness testimony and elimination conflicting testimonies. Witness might not exist or have inaccurate or incomplete of crash.	Accurate account of everything the driver sees, hears, and feels 10 seconds before, during, and 10 seconds after the crash.
Improvement in driver accountability.	Drivers in all vehicles are encouraged to drive more responsibly, since they can be held accountable when incidents occur.
Road rage, Car-jackers, and Hit-and-Run crime solving.	Provides visual record of the incident and opportunity for follow up with the authorities.
Improved police reports and crash reconstruction techniques.	It serves as a video, audio, and g-force notebook to enhance police and insurance companies' crash reports.
There is difficulty in assessing the extent of injuries at the scene of a crash.	Emergency personnel may also review the recording at the scene with any portable TV to identify the intensity of a crash, which will help catch serious injuries that may have been overlooked.
Staged crashes, insurance fraud, exaggerated claims can be difficult and costly to prove.	DriveCam is designed to reduce or eliminate auto insurance fraud by providing an easily understood and irrefutable video and audio playback of "exactly what happened."
Real time crash video is very rare.	The real time DriveCam can be used as a training tool to study crashes and improve highway safety through driver education.
Causes of crashes may involve multiple factors such as road or vehicle design, but may go undetected with traditional investigation techniques	G-Force readings can be carefully studied to determine exact tire traction, speed, and vehicle handling. Weaknesses can be identified and rectified.

Highway Department Uses: The Transportation Research Board staff reviewed the possible uses for EDR data as related to the highway environment. Generally, traffic and highway engineers are looking for data which will assist in the improvement of the roadside crash environment, especially run-off-road crashes which result in rollover. The following list describes their current needs.

- Verify speed & angle of impacts
- Assess side-slope effects on roll propensity
- Effectiveness of “softer” roadside devices
- Adequacy of severity indices
- Driver behavior in run-off-road events
- Off-road soil-tire interactions
- Effects of curbs
- Clear zone distance requirements
- Correlations to crash test results
- Potentials for supplementing police reports about the performance of roadway safety and traffic control features
- Validation of simulations
- Crash reconstruction
- Incident linkages to intelligent transportation systems and traffic management centers

10.0 Demonstration of EDR Technology

10.1 Overview

The working group wanted to provide some examples of EDR technology being used in today's crash investigation environment. The WG developed a potential set of systems for use to demonstrate EDR technology (See below).

Several demonstrations are presented here to give real-world examples of how EDRs are being used to help make motor vehicles safer, conduct research, and detect vehicle defects. These were selected for illustrative purposes, and the WG does not infer any findings from these particular examples, except that EDRs are being used.

Generally, the various EDR systems provide consistent crash information.

10.2 Potential Sources for Demonstration of EDR Systems

The working group developed a list of possible sources to demonstrate EDR applications. The following presents the sources, listed by major categories.

Major Category	Potential EDR Demonstration Sources
OEM	Light vehicles (passenger cars, SUVs, vans, pickups) Buses Heavy trucks
NHTSA	Special Crash Investigation Crash Injury Research and Engineering Network National Automotive Sampling System-Crashworthiness Data System Crash test evaluation program Crash avoidance research
NTSB	Various transportation modes, with concentration on surface transportation
Race Car	SAE Papers describing EDR uses in these vehicles
VDO North America	European systems and their impact on safety
ATA's TMC	Working Group activities related to EDRs
Military	The use of EDRs in military vehicle testing and operation
Vetronix Corporation	Recent activities related to development of a commercially marketed tool for downloading and presenting EDR data
TRB	Recent activities in A2A04 committee on roadside safety
Litigation	Civil and criminal justice system
Forensic Accident	Recent investigation where EDR data was used

10.3 Analysis of EDRs in NHTSA's NCAP and 208 Tests

NHTSA routinely conducts tests of new vehicles as part of our New Car Assessment Program (NCAP) and compliance test programs (FMVSS 208). During the 1998 model year (MY) test program, several GM vehicles were tested. After the tests were conducted, the air bag SDMs were removed from these vehicles and the EDR data stored during the crash were read to determine the Delta-V shape and total Delta-V for each vehicle tested. These data were then compared to the data collected by NHTSA's contractors during the conduct of the crash tests. The contractors' data collection generally consisted of accelerometers located near the seat tracks. Typically there were four accelerometers for each test. The individual traces were inspected for general agreement, and any outliers were dropped from the analysis. The

remaining data were averaged at each time step and integrated to determine the Delta-V vs. time characteristic.

There was a total of 21 1998 model year vehicle EDRs read during this effort, consisting of 15 cars, 2 vans, 2 SUVs, and 2 pickups. The test types consisted of 3 FMVSS 208 tests, 13 Frontal NCAP tests, and 5 Side NCAP tests.

Generally, there was good agreement between the contractors' instrumentation and the Delta-V trace from the SDM, although the EDR data from the SDM was slightly lower in magnitude than the integrated accelerometer data. One of the reasons the EDR data may be less than the accelerometer based data is the SDM does not start acquiring data until 2 g's of crash deceleration has been detected. Also, some of the SDM traces were incomplete. A typical trace comparison is shown in Figure 17.

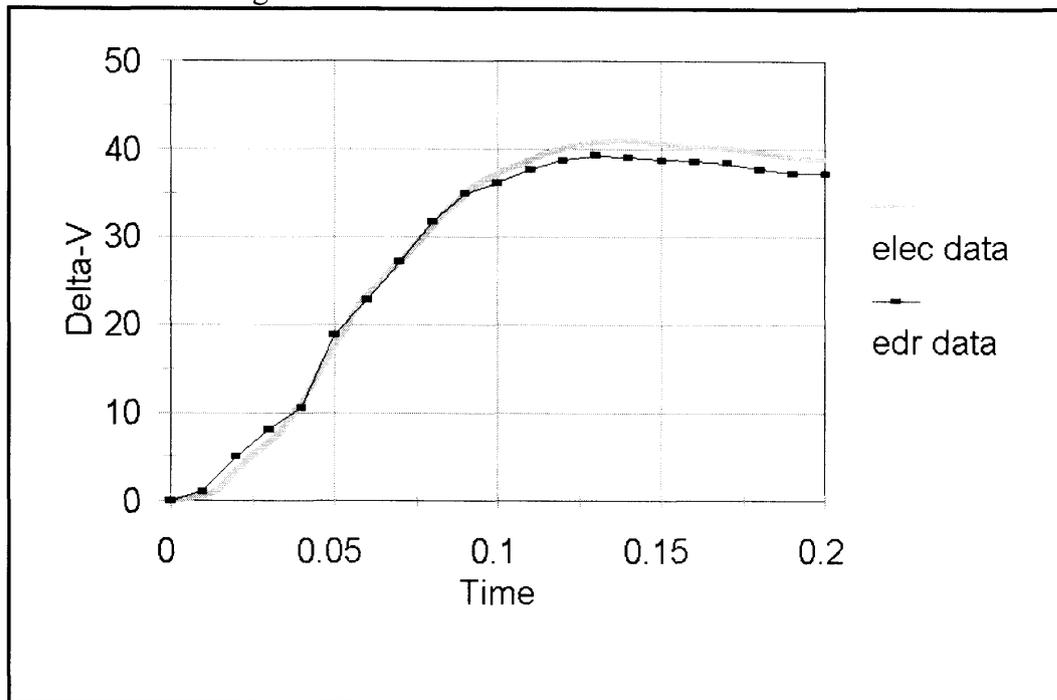


Figure 17. Comparison of EDR data and Crash Test Instrumentation Output.

10.4 IWI EDR Testing

The agency has an interest in monitoring the technology of aftermarket EDRs as well as that provided by vehicle manufacturers. Several companies are known to make aftermarket EDRs which have the capability of recording crash acceleration, velocity change, and other information. A series of one or more comparative crash tests of after market EDRs was planned. The purpose of the tests was to compare the data recorded by the EDRs to that collected by the routine data acquisition used for such crash tests. An invitation was extended to makers of aftermarket EDRs. The first company to respond with delivery of an EDR unit was Independent Witness, Inc. (IWI). The EDR unit manufactured by IWI is interesting in that they follow SAE guidelines for acquiring and processing crash acceleration data as prescribed in SAE J-211.

The IWI units were received in January 2001. The IWI units were utilized on three separate tests at the Vehicle Research and Test Center. The first was a FMVSS 208 compliance sled test of a Subaru Legacy. The second and third tests were crash tests of a moving deformable barrier (MDB) and a moving vehicle. As an example, the test involving the MDB and a 1997 Dodge Caravan (test # TRC 010129) will be examined. The test vehicle impacted the MDB front-to-

front, with a closing velocity of 70 mph, resulting in a deceleration in line with the longitudinal axis of the vehicle. The IWI EDR is capable of recording three orthogonal axes of acceleration and rotational motion. In this case, the motion was essentially confined to a single direction, so only the axis aligned with the vehicle longitudinal axis will be examined.

Figure contains an overlay of the IWI and instrumentation data signals filtered to channel class 180. The solid line is from the VRTC cg accelerometer, and the dashed line is from the IWI EDR box. Since there is no link in time between the two instruments, the traces have been “adjusted by eye” to align with each other. It is noted that the IWI trace is the same general shape and similar in magnitude to the VRTC instrument. Whereas the VRTC accelerometer trace records continuously, the IWI did not begin capturing data until approximately .005 seconds, and begins at approximately 18 g of deceleration. This is because the IWI instrument triggers at 2.5 g, and in severe collisions, the time lag causes the early portion of the signal to be lost. It is noted that the IWI signal has more oscillations than the VRTC signal. This may be due to the oscillations of the circuit board inside the EDR to which the IWI accelerometers are attached. The peak deceleration recorded on the VRTC accelerometer is 39 g, compared to 45 g from the IWI EDR.

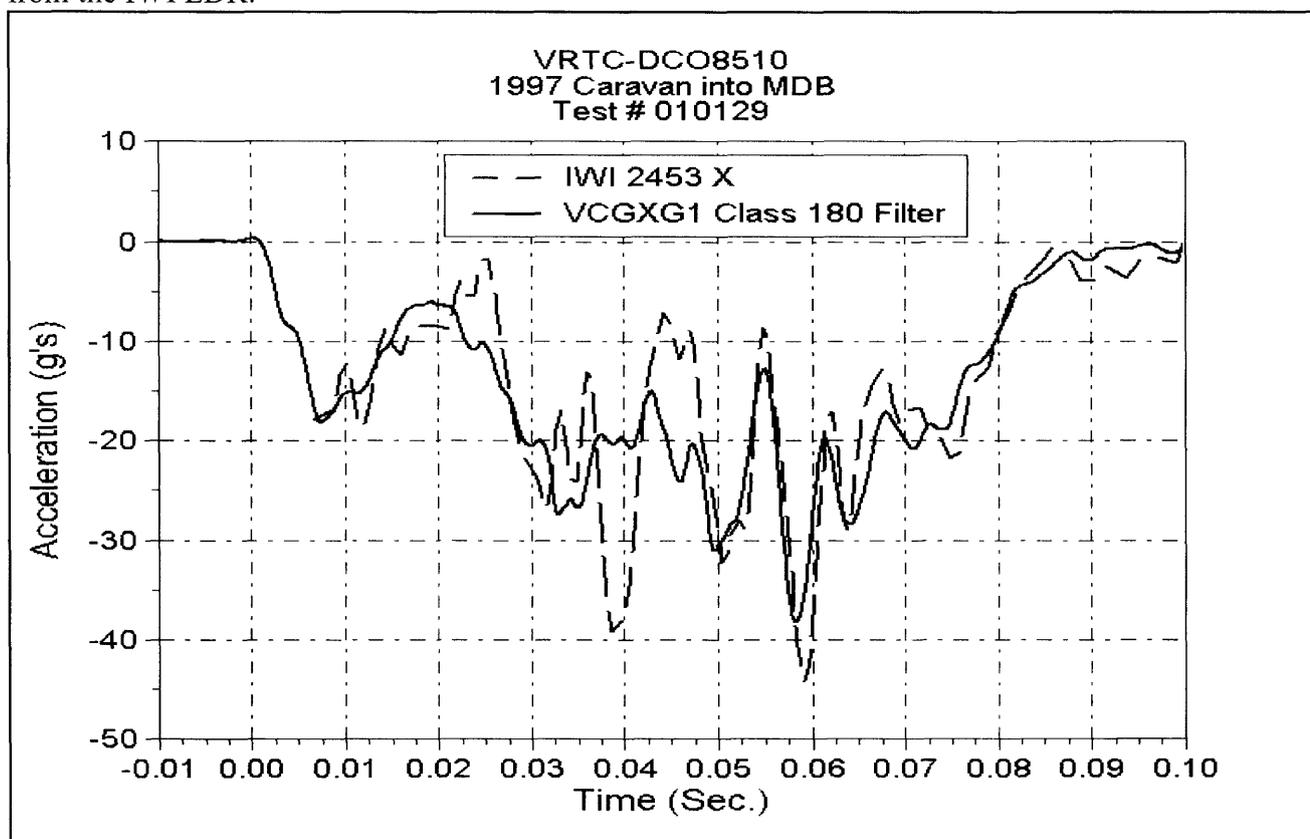


Figure 18. Overlay of the IWI and Test Instrumentation Acceleration Data Signals.

The VRTC signal was integrated to obtain the velocity signal, see Figure 19. The vehicle velocity starts at 35.2 mph and decreases to 2 mph at about 120 ms. The change in velocity is therefore 33.2 mph. The output from the IWI EDR directly lists the magnitude and direction of the delta-velocity. For this test, the IWI EDR computed a delta-v of 30.6 mph at 182 degrees. The difference in delta-v is likely due to that portion of the acceleration missed before the IWI EDR triggers and begins capturing data.

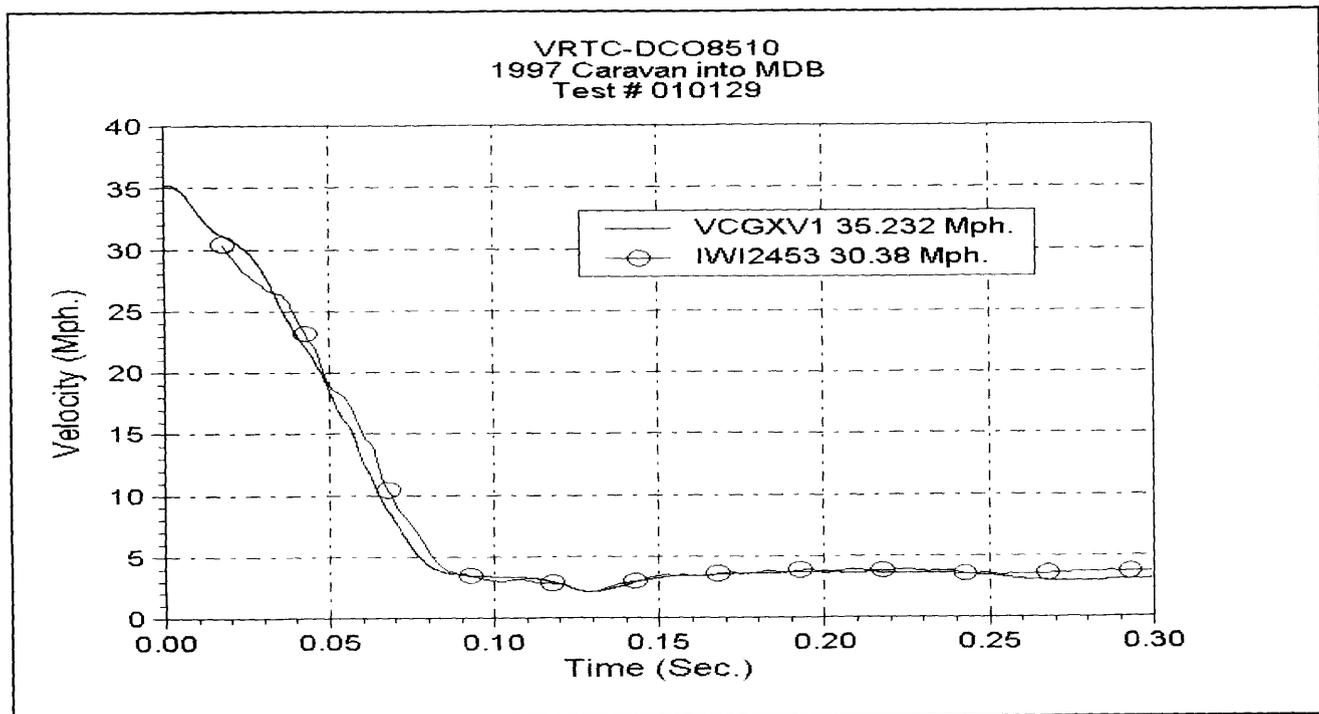


Figure 19. Overlay of the IWI and Test Instrumentation Delta-V Data Signals.

10.5 NHTSA EDR Data Collection Experience

NHTSA began collecting crash data from EDRs in the mid 1990s. The early efforts were cooperative between NHTSA and the automobile manufacturers. Data were typically collected by NHTSA's SCI program to support crash investigation activities. Most of these early cases were low speed air bag related fatalities that could not be accurately reconstructed by the WINSMASH algorithm. Prior to the Vetronix CDR tool, two methods were employed for obtaining the EDR data in the GM vehicles:

1. EDR boxes were removed by the SCI investigators, and sent to GM for downloading
2. GM sent a representative, typically a contractor, to the crashed vehicle to directly read the data.

As previously mentioned, NHTSA has equipped their crash investigation teams (SCI, NASS CDS and CIREN) with Vetronix CDR tools. Ford has provided five proprietary readers to the SCI and NASS. The teams were trained on proper use of these tools and now collect EDR data on a routine basis. To date, the NHTSA crash investigation teams have investigated over 100 crashes where an EDR was read.

Nineteen SCI cases contain EDR data with GM vehicles in which the manufacturer performed the download. In the 2000 data collection year, NHTSA teams began routinely collecting and entering EDR data into their Electronic Data Collection System (EDCS) database. The EDCS is utilized by all three (SCI, NASS CDS and CIREN) data collection systems as their common database. The EDCS was modified to contain a field which indicates if the case has an associated EDR file. This data element is part of the searchable electronic file associated with the database. Since the data collected by various vehicle manufacturers in their EDRs is not uniform, NHTSA is not able to store the output in the electronic file. Currently, NHTSA scans the paper output from the EDR report into the data base. This allows the researcher to review the various data elements (for example: DV for GM vehicles vs. acceleration profiles for Ford

vehicles). Future enhancements to the EDCS may include the automation of all the data elements available output from the EDR as variables and attributes.

The SCI and NASS CDS crash investigation teams have attempted 101 downloads; 94 of which, have been successful. The NASS CDS teams have attempted downloading 48 EDRs; 41 of which have been successful. The SCI has successfully downloaded 53 cases (25 GM, 28 Fords) involving an EDR. The following table presents these data as of January 1, 2001.

EDR Download Success by Manufacturer, Crash Program, and Downloading Agency						
Program	GM		FORD		Total	
	Attempted	Completed	Attempted	Completed	Attempted	Completed
SCI	7[18]*	7[18]	28	28	53	53
NASS CDS	41[1]	34[1]	6	5	48	41
Total	48[19]	41[19]	34	33	101	94
* The numbers in the brackets are counts of the EDRs downloaded by GM.						

The GM cases the NASS CDS teams were unable to read were either due to the lack of correct cables or to Vetronix software problems. Vetronix has sent out new cables and an upgraded software package that has corrected the download problems. The NASS CDS and SCI have noted a printing problem with the latest Vetronix software version.

The NASS CDS and SCI have successfully downloaded data from 33 Ford vehicles. In the only case not downloaded, the vehicle's electrical system was damaged during the crash, and the NASS CDS researcher was unable to remove the RCM.

10.6 EDRs in Conducting Crash Investigations

The following discussion was provided by Robert C. McElroy, Ph.D.; Forensic Accident Investigations, Inc.; Boca Raton, FL - (561) 995-6781; November 2000. Accurate data protects the public and the transportation system. Improvements in vehicles, highways, operator performance, and infrastructure require analytical assessment methods for optimal benefits. Accountability for each element in the total fabric of transportation requires data which can be analyzed by researchers, in order that incremental improvements be implemented. Each segment of the entire transportation system is a consumer of the data. Scientific data are necessary to explain and address crashes and their effect on a particular segment of the transportation system. EDRs are a logical way to enhance transportation safety and improve the transportation system.

The following presents an example of a crash which may have been related to a brake line failure.

This vehicle was involved in a collision in 2000 in the city of North Miami, Florida. As reported by the driver, he indicated that he was approaching slower traffic. In attempting to slow for traffic he pressed the brake but the car did not stop as expected. Inspection of the vehicle revealed that a flexible brake line connecting the master cylinder to the Antilock Brake System (ABS) hydraulic controller was leaking brake fluid when the brake pedal was pressed. A technician removed both brake lines connecting the master cylinder to the ABS module.

EDR Data: This vehicle was equipped with an OEM EDR which stores pre-collision vehicle data including speed, brake application, and throttle position. Technical post crash vehicle inspection was coupled with EDR data to significantly reduce investigation time.

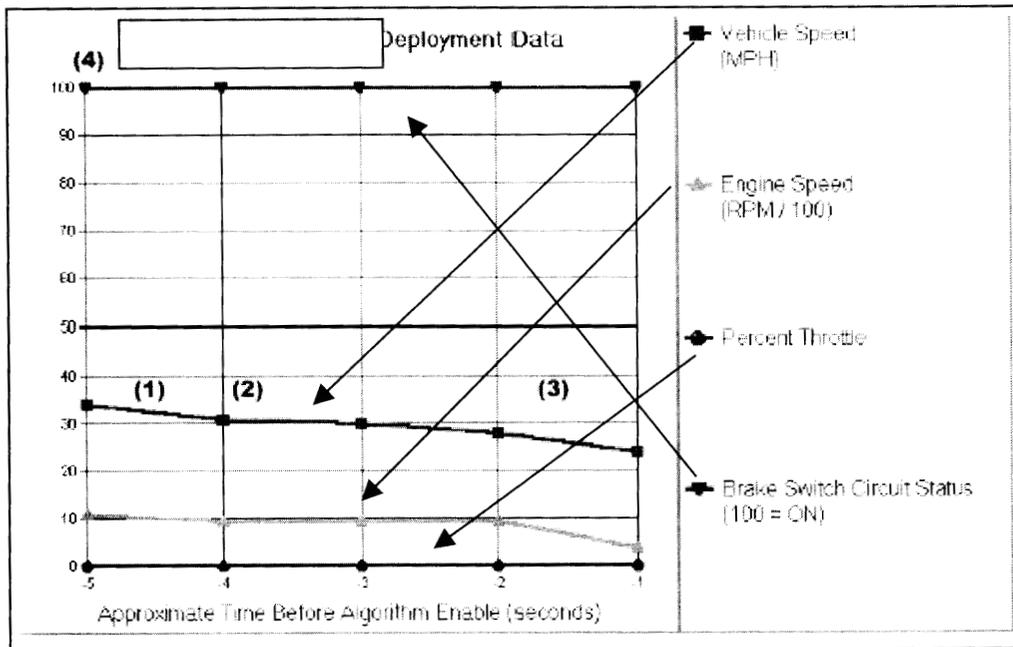


Figure 20. EDR Graphical Output.

As shown graphically in Figure 20 and in text format in Figure 21, initial speed is 34 mph when brakes are applied at least 5 seconds before algorithm enable (impact registration).

- (1) Vehicle decelerates.
- (2) Vehicle no longer decelerates as rapidly, indicating possible relationship to brake line failure.
- (3) Impact occurs on right side of graph.
- (4) Brake is applied during entire time.

162JB5245Y7100472 System Status At Deployment				
SIR Warning Lamp Status	OFF			
Passenger Front Air Bag Suppression Switch Circuit Status	ON			
Ignition Cycles At Deployment	2356			
(4)				
PRE-CRASH DATA			Electronic Data Validity Check Status = VALID	
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	34	1088	0	ON
-4	31	960	0	ON
-3	30	960	0	ON
-2	28	960	0	ON
-1	24	364	0	ON

Figure 21. EDR Text Output.

10.7 EDRs in Conducting Defect Investigations

In a report prepared for NTSB's "International Symposium on Transportation Recorders" in 1999, an example of using an EDR to assist the manufacturer and the government in determining the cause of the inadvertent airbag deployment safety problem was presented. Downloading the event data from a sample of the inadvertent deployment vehicles showed no fault codes present and that the SDM algorithm had commanded the airbags to deploy. The typical DV increased smoothly until it leveled off at approximately 70-120 ms and was usually at least 12 mph in

magnitude. This confirmed the design goal of deploying the airbags only if the change in longitudinal vehicle velocity is expected to exceed that observed in 9-14 mph fixed barrier impacts. However, the history recorded for the inadvertent deployments was typically a short duration event (20 ms or less) with a total velocity change of less than 7 mph. This variation from the typical deployment event history suggested an unusual sensor deceleration environment. After extensive laboratory tests and computer simulation work, the environment was found to be similar to that produced by small rocks or debris striking the underside of the vehicle with high impulsive energy. Ultimately a sensor calibration change was made to desensitize the SDM's response to these relatively rare events. This investigation was aided considerably by the EDR data.

10.8 EDRs in Determining Crash Severity

NHTSA's primary metric for representing crash severity is the vehicle's change in velocity (DV). Currently, NHTSA uses the WINSMASH computer algorithm estimate DV for a crash. This algorithm relies primarily on stiffness parameters derived from 35 mph full-width rigid barrier impact tests, which tend to be short in duration. Real world crashes (many of which are longer in duration compared to the 35 mph barrier tests) and less idealized crashes involving yielding fixed and narrow objects, under-rides, or multiple impacts are beyond the capabilities of WINSMASH. NHTSA can now use the output from EDRs to supplement the DV crash severity estimate currently derived from post-crash vehicle inspections. NHTSA crash investigators attempt to make such estimates for all crashes investigated, but because of limitations, only about 38 percent of the cases have DV information reported.

Figure 22 shows a field crash from NHTSA crash files involving a 1998 Chevrolet Malibu that struck a heavy, parked truck in a severe bumper under-ride impact. Such crashes typically generate long crash pulses. WINSMASH estimated a DV of 23 mph, while the investigator noted this DV estimate appeared to be low. The EDR indicated a DV of approximately 50 mph. This again shows the value of having EDRs.



Figure 22. Field Crash from NHTSA Crash Files where EDR Data Were Used.